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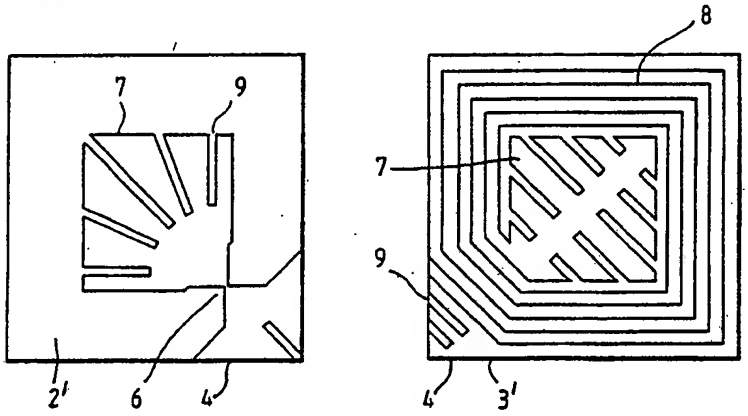

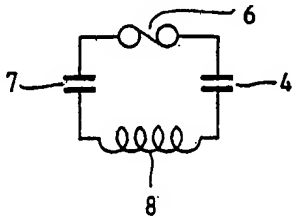

(57) Abstract

An antipilferage tag is disclosed which includes a resonant circut adapted to receive an RF signal and to transmit a response signal when interrogated by said RF signal. The tag includes circuit components constituted by or fabricated from a metallised layer supported by a dielectric material.

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ANTIPILFERAGE MARKERS

Introduction

This invention relates to antipilferage markers of the type traditionally referred to as radiofrequency (RF) tags. These tags typically use a capacitor-inductor combination to provide a circuit having a characteristic electromagnetic resonance which, in use, receives an RF signal in an interrogation zone and, in response thereto, transmits a signal, e.g. to a receiver in order to generate an alarm indication. This invention is particularly concerned with a novel means for fabricating the tag circuit.

Prior Art

The general operation and certain methods of assembly of such RF tags are disclosed in patents such as those of Lichtblau (US 3810247, US 3863244, US 3967161, US 4021705). In order to construct the appropriate circuit elements, two or more layers of metal are required. In the prior art this has been achieved by the exclusive use of metal foils of substantial thickness (typically several microns or several tens of microns) which are normally manufactured by rolling techniques. The foils are usually cut, slit, or etched into complex shapes, and are often folded to form the two layers. For example, U.S. Patent No. 4,910,499 (S. Eugene Benge, assigned to Monarch Marking Systems, Inc.) discloses a deactivatable tag useable with an electronic article surveillance system and which comprises a pair of spiral conductive elements which are mutually inverse in their orientation. The spirals are formed by a cutting process. The disadvantages of the prior art processes are in the amount of metal required, and in the complex patterns and alignments which are needed in manufacture.

Brief description of the invention

According to one aspect of the present invention, there is provided a tag which includes a resonant circuit adapted to receive an RF signal and to transmit a response signal when interrogated by said RF signal, characterised in that at least a part of the tag is constituted by, or is formed from, a precursor comprising a polymer dielectric having a thin, metallised coating on one surface thereof. Advantageously, the precursor comprises a polymer dielectric carrying the thin, metallised coating on one surface thereof and a bulk metal layer on the opposite surface thereof.

According to a second aspect, the present invention provides an antipilferage tag which includes a resonant circuit adapted to receive an RF signal and to transmit a response signal when interrogated by said RF signal, characterised in that the tag includes circuit components constituted by or fabricated from a metallised layer supported by a dielectric material.

Typically, the present invention enables one or more layers of metallisation to be used to replace one or more of the normal metal layers. The use of a metallised layer as part of the RF tag circuit gives many potential advantages over the prior art. For example, it may permit lower-cost construction, involving fewer laminated layers; it may permit the easier formation of a fusible link for tag deactivation; it may allow the production of a more flexible label for application to goods; and it may permit a number of manufacturing simplifications which (for example) may reduce the amount of dissolved metal and hence the quantity of chemicals used if an etching process is being employed.

<u>Detailed description of the invention</u>

The metallised layer used in this invention may be formed by a number of conventional methods. They

include evaporation, sputtering, chemical or vapour deposition, and electroplating. The material metallised may be any suitable metal, but copper and (more preferably) aluminium have optimal properties. The metallisation will be typically less than 1 micron thick; in the preferred embodiment it is as thin as 0.1 micron.

Additional features that can be incorporated into the tag of the present invention include the breaking up of the area of the capacitor electrodes (especially on the side of the tag where thick metal is used, i.e. on the coil side of the tag) to reduce losses from eddy currents. Appropriate features to accomplish this effect are illustrated by Figure 2, and may be incorporated into the mask pattern if the tag is formed by etching.

The use of a two-capacitor circuit (for example 4 and 7 as shown in Figure 2, and described in greater detail hereinafter) to avoid a metallic through-connection between the two metal layers of the tag is particularly preferred, as it is difficult to form reliable connections to the metallised layer in the conventional stamping process. The two capacitors need not be of equal area; a more efficient use of area results if the outer capacitor is smaller than the inner one, as this gives a larger effective area for the coil on a given sized tag. To avoid any contribution to resonant frequency uncertainty from small misalignments in the upper and lower metal patterns, the capacitor plates are advantageously slightly smaller on one side of the tag than the other, such that the overlapping area does not vary for small displacements.

Tags which are to be used in electronic article surveillance systems need to have the capacity to be deactivated, so that their signal generating function

can be disabled by authorised personnel, e.g. at a goods check-out station. The deactivation process preferably employed in tags of the present invention is to cause a narrow region of the metallised film to go into open circuit under a sufficiently high level of RF field swept through the resonant frequency. This can be achieved by conventional means. The use of the metallised layer as the deactivating means a represents novel variation on the prior art technique of fusing part of the coil, and permits low cross section structures that blow under reasonable field levels to be easily defined. Accordingly, in another aspect, the present invention provides an antipilferage tag which includes a resonant circuit adapted to receive an RF signal and to transmit a response signal when interrogated by said RF signal, characterised in that the tag includes deactivating means in the form of a circuit component constituted by or fabricated from a metallised layer supported by a dielectric material.

The deactivation field can be reduced if a narrower neck is formed in the metallisation pattern, but any large improvement would be at the expense of increased resistive losses and hence reduced Q. Thicker metallisation may be deposited in areas other than the fusing zone to reduce the overall resistivity; this may be achieved, for example, by electrodeposition, a further evaporation process, or electroless plating.

Lower field deactivation can be promoted without increasing resistive losses by keeping the fusible area under mechanical stress, in a similar way to that in which fast blow fuses incorporate a spring. This provides more consistent fusing at lower field strengths. This can be incorporated at manufacture by embossing the area surrounding the fusible link. This is significantly different from the technique disclosed

in US 4,498,076 (Lichtblau, 1985), which refers to mechanically enhanced short circuiting of the tag capacitor rather than open circuiting of a fuse. Alternatively the stress can be introduced by heating areas of the tag around the fuse during manufacture.

Other deactivation techniques, such as voltage induced dielectric breakdown between the two metal surfaces, or between different parts of the coil, may also be used if desired.

The use of a metallised layer as part of the RF tag circuit gives many potential advantages compared with the prior art of using bulk metal, e.g. aluminium, on both sides; for example it may permit lower cost at construction, fewer laminated layers, easy formation of a fusible link for deactivation, less dissolved metal if the coil is etched, less chemical usage and less waste.

In a further aspect, the invention provides a method of fabricating an antipilferage tag, which method comprises:

(a) bonding a metal layer to one surface of a laminar dielectric material;

(b) depositing a thin, metallised coating onto the opposite surface of said dielectric material; and

(c) generating circuit components from said metal layer and from said thin, metallised coating.

The invention will now be illustrated, by way of example, with reference to the accompanying drawings, in which:

FIGURE 1 shows the starting materials for tag production before the circuit has been formed;

FIGURE 2 shows suitable conductive patterns of metallisation (Fig 2a being those on one side of the tag, while Fig. 2b being those on the opposite side of the tag) and an equivalent circuit diagram (Fig. 2c);

FIGURE 3 is an example of mask etch patterns; and

FIGURES 4 and 5 illustrate an alternative tag construction in accordance with this invention.

Referring now to Figure 1, a polymer dielectric 1, typically 8 to 20 microns thick, and typically a polyester or polypropylene, carries a metallisation layer 2, typically aluminium 0.1 micron thick. The opposite side of polymer dielectric 1 carries a bulk conductor layer 3, typically a 20 micron layer of aluminium. Lamination of the bulk metal 3 to the polymer 1 is shown at 4; this may be either by an adhesive layer (typically 2 microns thick), or by direct hot nip or extrusion of the polymer 1 onto the bulk metal foil 3.

Referring next to Figure 2, an etched pattern 2' is shown on the metallised side of the tag (left hand portion of the Figure), and an etched pattern 3' is shown on the opposite (bulk metal) side of the tag (right hand portion of the Figure). The tag (also commonly termed a label) is typically 40 mm square. The area 4 constitutes an external capacitor, and a fusible link 6 is defined by an etched pattern (as shown) on the metallised side of the tag. The fusible link 6 connects the external capacitor 4 with the areas 7, which constitute an internal capacitor. The metallised areas 8 constitute a coil. This preferably has eight turns, each preferably 0.8 mm wide on 1 mm in pitch. Slits 9 are present in the positions indicated in order to reduce eddy current losses in the capacitor plates, which are typically 0.2 mm thick. Note that the slits of opposing capacitor plates cross approximately at right angles in this embodiment, minimising capacitance errors from any misregistration of etch patterns.

The presently preferred route for manufacturing the RF tags of this invention is based on well established material processing techniques using

readily available starting materials. The following Examples illustrate these techniques:

EXAMPLE 1

This Example illustrates the production of a tag having a metallised pattern generally as shown in Figure 2. The preferred starting material is a composite web of aluminium foil laminated to metallised polypropylene (as shown in Figure 1). This gives a lower loss polymer dielectric layer twenty microns thick, with twenty microns of aluminium on the bulk metal side, and 0.05 microns of aluminium on the other (metallised) side.

Processing

The web is simultaneously printed on both sides with the required etch resist patterns in a gravure cylinder printing process. Registration holes are inserted into the edges of the web at this stage to provide proper location of the film at the label stamping stage (see below). The resist is then dried and the web fed through the acid based etchant bath to generate the desired metallisation patterns. The completed circuit is then neutralised and dried; the etch resist may not have to be removed.

Label conversion

This requires the addition of a paper top layer on one side of the circuit, and pressure sensitive adhesive and release paper on the other, before the labels are stamped out making use of the registration holes put into the circuit at the resist printing stage.

Variations on manufacturing route

Starting material

Use of polyester as the polymer layer: this has higher dielectric loss than polypropylene, but has the

advantage that aluminium/polyester laminate is readily available.

Bonding of the aluminium and polymer

Use of glue bonding, or direct hot nip of the polymer to the aluminium, is possible. The major concern with both techniques is to produce a consistent and uniform dielectric thickness with good bonding between the layers. If a glue layer is used its thickness should be minimised (one micron ideally), as it represents a higher loss portion of the dielectric.

Processing

The present invention permits the following features to be incorporated into the processing or tag fabrication steps:

A. Optimisation of the basic etching process to minimise cost;

B. Reduction of the amount of material removed; Leaving resist in place at end of process;

C. Printing and etching of both sides of the tag simultaneously;

D. Shot blasting of the aluminium laminate using a rubber compound resist printed onto the foil to define the coil pattern. This technique could also be used to etch the pattern on the metallised side of the plastic; alternatively this pattern could be formed at the evaporation stage using a suitable mask, and then just the coil pattern shot blasted.

E. Connecting the two aluminium layers together by stamping through the plastic at the outside end of the coil. This saves having capacitor plates at both ends of the coil, but may cause problems if used to connect to an extremely thin evaporated layer of metallised aluminium.

Label forming

F. The choice of label top surface can be wide, as

the active portion of the tag is thin, and hence of low stiffness. The stiffness is also lowered by the etching of the bulk aluminium in order to generate a coil. This should allow for Roboskin, thermal and conventional paper to be used.

G. Manufacture of traditional shaped edged labels with adjacent rows of labels overlapping minimising waste - the tag etch patterns have to be created in this way to start with.

EXAMPLE 2

A different label structure in accordance with this invention has also been produced, where aluminium/polyester laminate is etched into coils, and subsequently laminated to a polypropylene layer which has previously been metallised in strips. This forms a coil capacitor circuit with the polypropylene as the dielectric, and the metallised strips forming the capacitors and current return path. This structure is illustrated in Figures 4 and 5 of the drawings. Figures 4a and 5a show the 'coil' side of the tag, while Figures 5a and 5b show the strip capacitors on the opposite side of the tag. The arrangements of Figures 4 and 5 differ in their geometries, as shown. In Figure 4b, the polypropylene dielectric 41 is eight microns thick and carries strips of metallised aluminium coating 42 which (in this embodiment) are 6mm wide. The resistivity is 0.5 ohms/square mm. In Figure 5b, a similar polypropylene dielectric carries a diagonally disposed strip 52 of metallised aluminium coating which incorporates laser cuts 61a, 61b etc. which constitute a fusible link between portions of the metallised strip; when subjected to a high RF field swept through the resonant frequency of the circuit, these links fuse, thereby deactivating the tag. An alternative construction is shown in Figure 5c, where different geometries of fusible metallised areas are

depicted. The overall lamination is illustrated in Figure 5d, where a top layer 70 approximately 40 microns thick is secured over the aluminium coil 53, which is approximately 25 microns thick; this is over the polypropylene dielectric layer 51 (eight microns thick); and the metallised, strip-form zones 61 are carried by layer 51. The metallised strips 61 are approximately 70nm thick.

The mode of implementation illustrated in Figures 4 and 5 has the advantage that the polymer layer can be obtained metallised in stripes at low cost, and needs no further processing after it has been laminated to the coil.

CLAIMS:

1. A tag for use in electronic article surveillance systems, which tag includes a resonant circuit adapted to receive an RF signal and to transmit a response signal when interrogated by said RF signal, characterised in that at least a part of the tag is constituted by, or is formed from, a precursor comprising a polymer dielectric having a thin, metallised coating on one surface thereof.

2. An antipilferage tag which includes a resonant circuit adapted to receive an RF signal and to transmit a response signal when interrogated by said RF signal, characterised in that the tag includes circuit components constituted by or fabricated from a metallised layer supported by a dielectric material.

3. A tag as claimed in claim 1, characterised in that said precursor comprises a polymer dielectric having a thin, metallised coating on one surface thereof and bulk metallic layer on the opposite surface thereof.

4. A tag as claimed in claim 1, 2 or 3, characterised in that said thin, metallised coating is formed by evaporation, sputtering, chemical or vapour deposition, or electroplating.

5. A tag as claimed in claim 1, 2, 3 or 4, characterised in that the material which constitutes said thin, metallised coating is copper or aluminium.

6. A tag as claimed in any preceding claim, characterised in that said thin, metallised coating is less than 1 micron thick.

7. A tag as claimed in claim 6, characterised in that said thin, metallised coating is 0.1 micron in thickness.

8. A tag as claimed in any preceding claim, characterised in that it includes a two-capacitor circuit.

9. A tag as claimed in claim 8, characterised in that there is an outer capacitor and an inner capacitor.

10. A tag as claimed in claim 9, characterised in that the outer capacitor is smaller than the inner one.

11. A tag as claimed in claim 8, 9 or 10, characterised in that the capacitor plates are slightly smaller on one side of the tag than the other.

12. An antipilferage tag which includes a resonant circuit adapted to receive an RF signal and to transmit a response signal when interrogated by said RF signal, characterised in that the tag includes deactivating means in the form of a circuit component constituted by or fabricated from a metallised layer supported by a dielectric material.

13. A tag as claimed in any preceding claim, characterised in that the deactivating means is a narrow region of the metallised film which constitutes a fusible link.

14. A tag as claimed in claim 13, characterised in that said fusible link is capable of being fused, thereby going into open circuit, when subjected to a sufficiently high level of RF field swept through the resonant frequency of the circuit.

15. A tag as claimed in claim 13 or 14 when appendant to claim 8, characterised in that said fusible link is constituted by a conductive path between one of the capacitor plates of said inner capacitor and the adjacent capacitor plate of said outer capacitor.

16. A tag as claimed in any preceding claim, characterised in that the tag is formed by bonding together two laminar components, the first being an aluminium/polyester laminate the aluminium of which has been etched into coils; and the second being a polypropylene layer onto which has been deposited thin,

metallised strips.

17. A method of fabricating an antipilferage tag, which method comprises:

(a) bonding a metal layer to one surface of a laminar dielectric material;

(b) depositing a thin, metallised coating onto the opposite surface of said dielectric material; and

(c) generating circuit components from said metal layer and from said thin, metallised coating.

18. A method according to claim 17, characterised in that said thin, metallised coating is etched to generate the desired circuit geometry.

Fig. 1

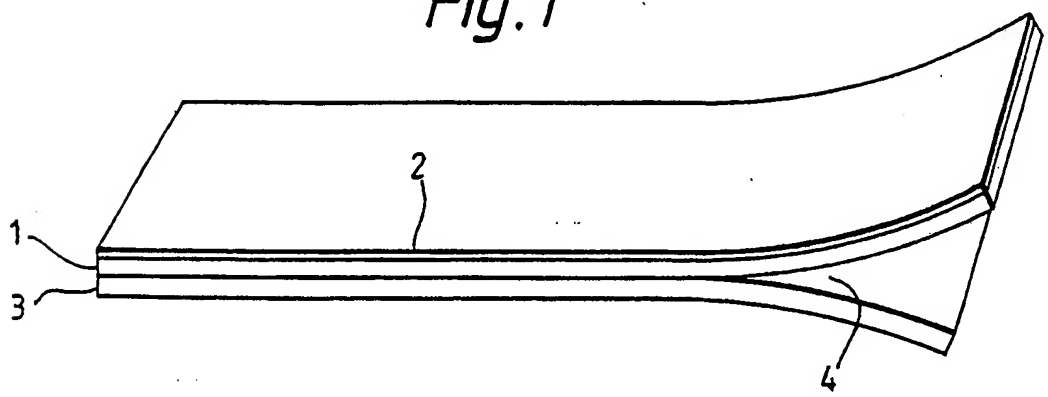


Fig. 2a

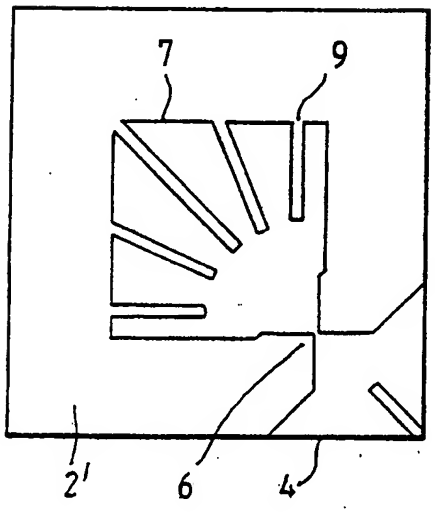


Fig. 2b

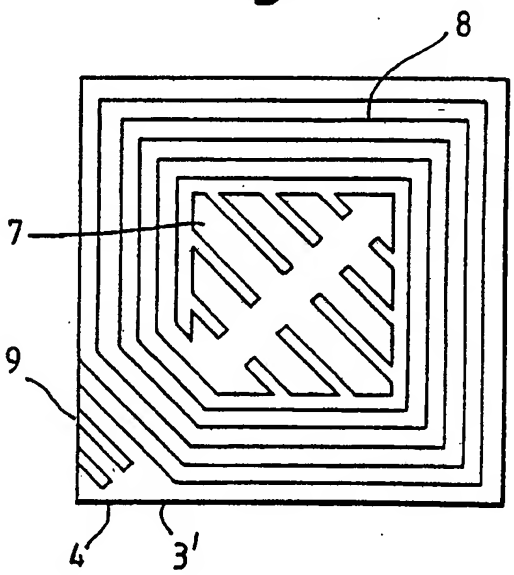
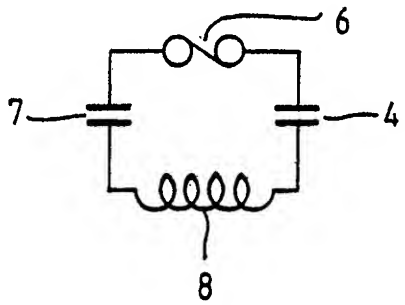


Fig. 2c



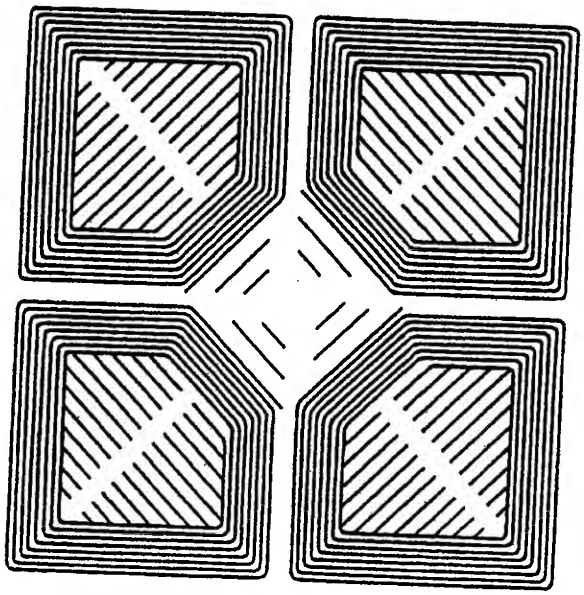


Fig. 3

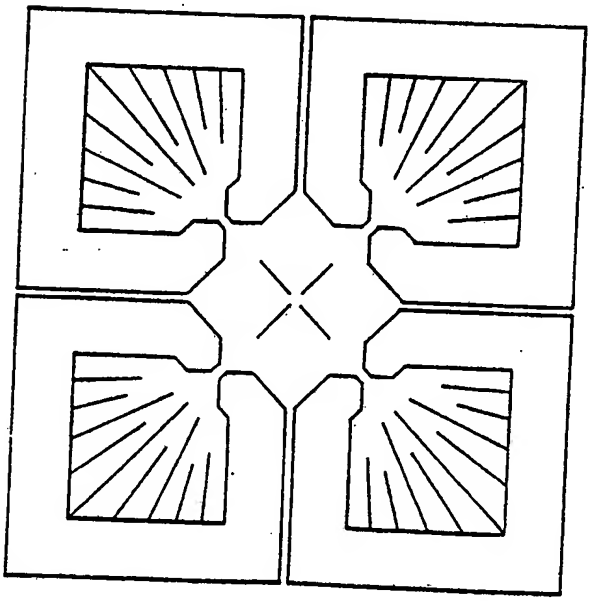


Fig. 4a

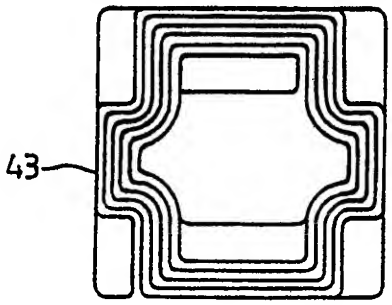


Fig. 4b

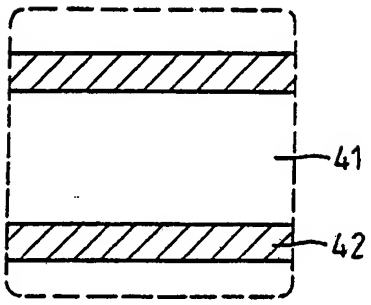


Fig. 5a

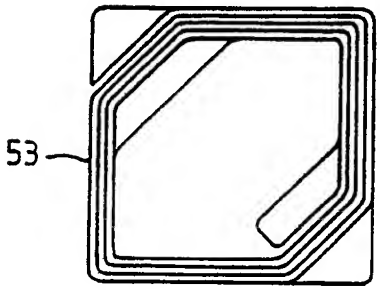


Fig. 5b

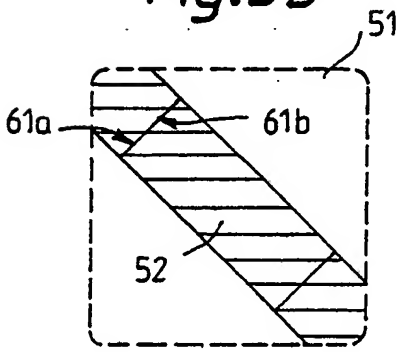


Fig. 5c

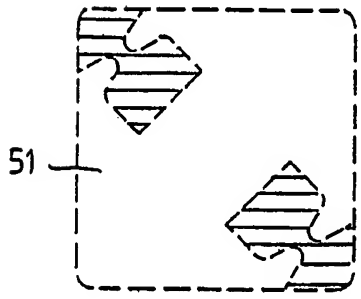
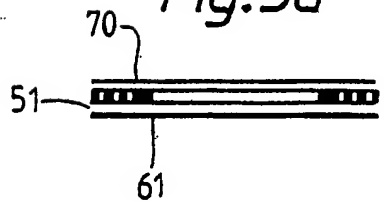


Fig. 5d



INTERNATIONAL SEARCH REPORT

PCT/GB 92/01250

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 G08B13/24

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	G08B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category°	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X Y	US,A,4 835 524 (LAMOND ET AL.) 30 May 1989 see figures 1-3 see column 3, line 18 - column 4, line 10 see column 5, line 5 - line 9	1-5, 12-14,17 1,8,9,11
Y	US,A,3 810 147 (LICHTBLAU) 7 May 1974 see figures 3-5 see column 4, line 9 - line 58	1,8,9,11

° Special categories of cited documents :[10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
26 OCTOBER 1992	13. 11. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	WEISS P.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9201250 SA 62455

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 26/10/92
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-4835524	30-05-89	None	
US-A-3810147	07-05-74	DE-A- 2263905	12-07-73
		FR-A,B 2166216	10-08-73
		GB-A- 1406500	17-09-75
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